with an n-type drift layer **2** when the alternate arrangement of the n-type drift regions **2** and the p-type silicon regions **3** is formed.

[**0093**] Other Embodiment

[**0094**] The semiconductor device in the first embodiment can be manufactured using the method for manufacturing the semiconductor device in the second embodiment. That is, although the low dopant concentration region **41** is formed at the outermost ends at the steps of forming the super junction **11** in the second embodiment, the low dopant concentration region **41** may not be formed. In other words, although the substrate **32** is heated in a non-oxidizing and non-nitridizing atmosphere such that the dopant concentration in the n-type drift layer **2** is maintained to be the predetermined one in the first embodiment, it is possible to permit the n-type drift layer. **2** to have the predetermined dopant concentration by diffusing the dopant that has been added to the heating atmosphere into the n-type drift layer **2** to increase the dopant concentration in the n-type drift layer **2**.

[**0095**] In this instance as well, as explained in the second embodiment, the n-type drift layer **2** can be substituted by a p-type layer, which is different in conductivity type from the n-type drift layer **2**. In that case, the dopant concentration of the p-type layer is set to be lower than the dopant concentration of the p-type silicon regions **3**, and the substrate **32** is heated in a non-oxidizing and non-nitridizing atmosphere with a pressure of 1 to 600 Torr containing a gas that includes an n-type dopant. The n-type drift layer **2** is formed on the n^+-type substrate **1** by diffusing the n-type dopant into the p-type layer.

[**0096**] Each power MOSFET in the above embodiments is an n channel power MOSFET, in which the first conductivity type is n-type and the second conductivity type is p-type. However, the present invention can be applied to a p channel power MOSFET, in which the conductivity types of the elements are opposite to those in the n channel power MOSFET.

[**0097**] In the above embodiments, the present invention has been applied to power MOSFETS. However, the present invention can be applied to IGBT, in which a collector is substituted for the drain and an emitter is substituted for the source, and thyristor.

[**0098**] The semiconductor devices in the above embodiments are power MOSFETs having a super junction structure. However, the present invention can be applied to other semiconductor device, in the manufacturing process of which a trench is filled with an epitaxially grown film.

What is claimed is:

1. A method for manufacturing a semiconductor device, the method comprising:

forming a trench in a predetermined layer of a semiconductor substrate;

heating the substrate having the trench in a non-oxidizing and non-nitridizing atmosphere containing a dopant or a compound that includes the dopant in order to smooth surfaces of the trench and to maintain a dopant concentration in the predetermined layer to be a predetermined concentration before the heating is treated, wherein the conductivity type of the dopant contained in the non-oxidizing and non-nitridizing atmosphere is the same as that of a dopant initially contained in the predetermined layer; and

forming an epitaxially grown film to fill the trench.

2. A method for manufacturing a semiconductor device, the method comprising:

forming one layer out of a first conductivity type drift layer and a second conductivity type layer on a first conductivity type semiconductor substrate, which forms a drain region;

forming first trenches in a surface of the one layer;

heating the one layer having the first trenches in a non-oxidizing and non-nitridizing atmosphere containing a dopant or a compound that includes the dopant in order to smooth surfaces of the first trenches and to maintain a dopant concentration in the one layer to be a predetermined concentration before the heating is treated, wherein the conductivity type of the dopant is the same as that of a dopant contained in the one layer;

forming the other layer out of the first conductivity type drift layer and the second conductivity type layer to fill the first trenches by epitaxial growth in order to form an alternate arrangement of first conductivity type drift regions and second conductivity type first semiconductor regions;

forming first conductivity type second semiconductor regions on the first conductivity type drift regions;

forming a second conductivity type base layer on the first semiconductor regions and the second semiconductor regions;

forming second trenches that extend through the base layer to reach the second semiconductor regions;

forming gate insulating films on surfaces of the second trenches; and

forming gate electrodes on the gate insulating films.

3. The method according to claim 1, wherein a dopant concentration in the non-oxidizing and non-nitridizing atmosphere is within the range of 1×10^{15} to 1×10^{18} cm^{-3};

4. A method for manufacturing a semiconductor device, the method comprising:

forming a trench in a predetermined layer of a semiconductor substrate;

heating the substrate having the trench in a non-oxidizing and non-nitridizing atmosphere containing a dopant or a compound that includes the dopant in order to smooth surfaces of the trench and to diffuse the dopant contained in the non-oxidizing and non-nitridizing atmosphere into the predetermined layer and partially increase a dopant concentration in the predetermined layer to be a predetermined concentration higher than that before the heating is treated; and

forming an epitaxially grown film to fill the trench.

5. A method for manufacturing a semiconductor device, the method comprising:

Preparing a first conductivity type semiconductor substrate, which forms a drain region;